Planning Systems: Architectural Considerations and Future Directions

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Overview

- Rationale
- Future System
- Next Steps

Workshop Guidance

- What are the major mission and/or operations requirement(s) which drive technological development and innovation?
- What are the novel and/or original ideas and concepts that were (will be) contributed to driving technological development and innovation?
- Can future area(s) of further contribution be identified based on what has been achieved so far?
- Can a roadmap for future development/exploitation be produced?

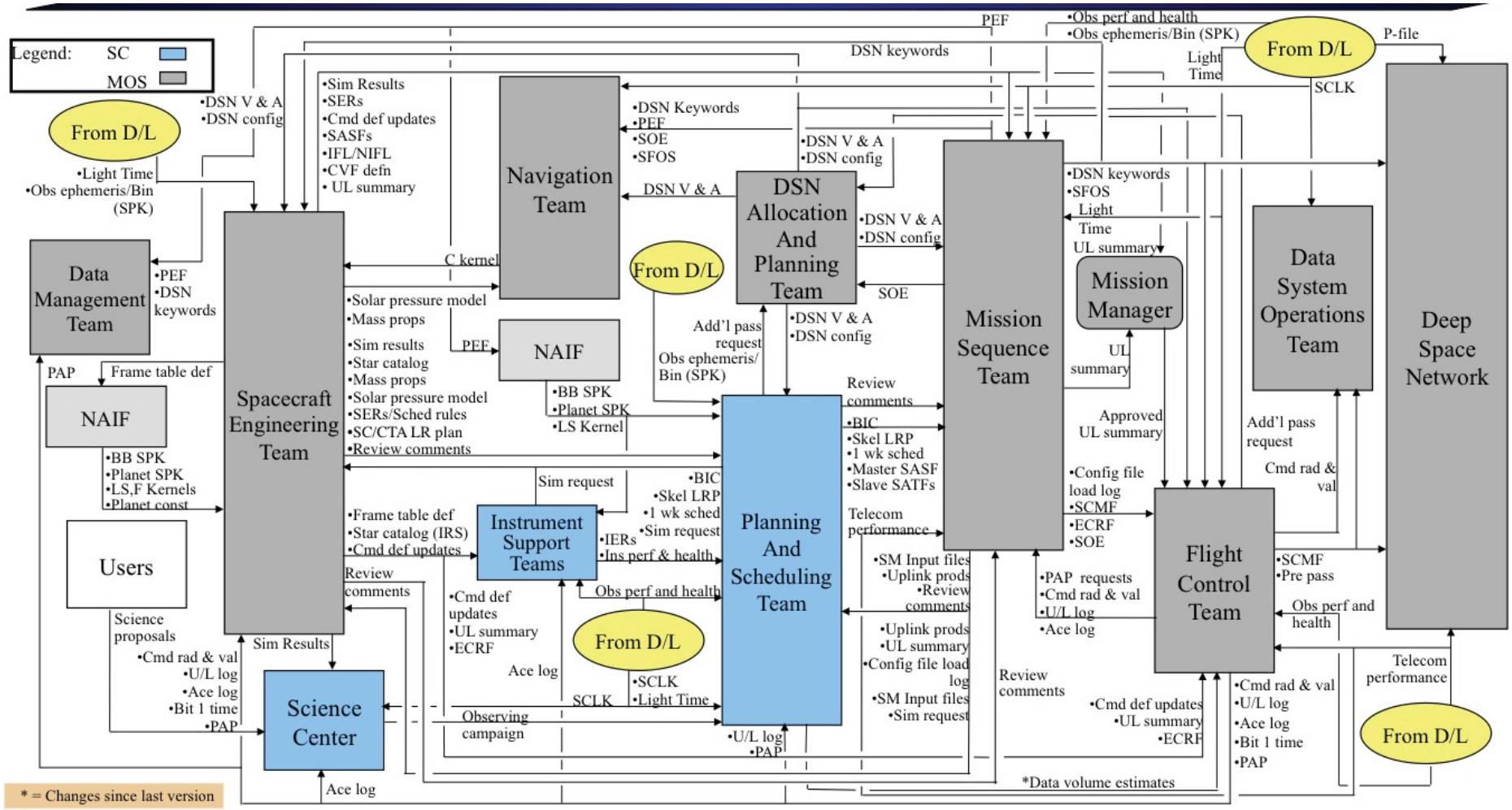
Cost-Driving Issues

- "Operations Systems just do Planning and Processing" (a.k.a. Uplink & Downlink)
  - Waterfall mentality
  - Organizational & conceptual "stove-piping"
  - MOS is "just a bunch of documents"
- Lack of explicit understanding of relationships between software & process
- File-based information model is inefficient & drives maintenance costs
- ***Lack of clarity about the central purpose of a Mission Operations System***

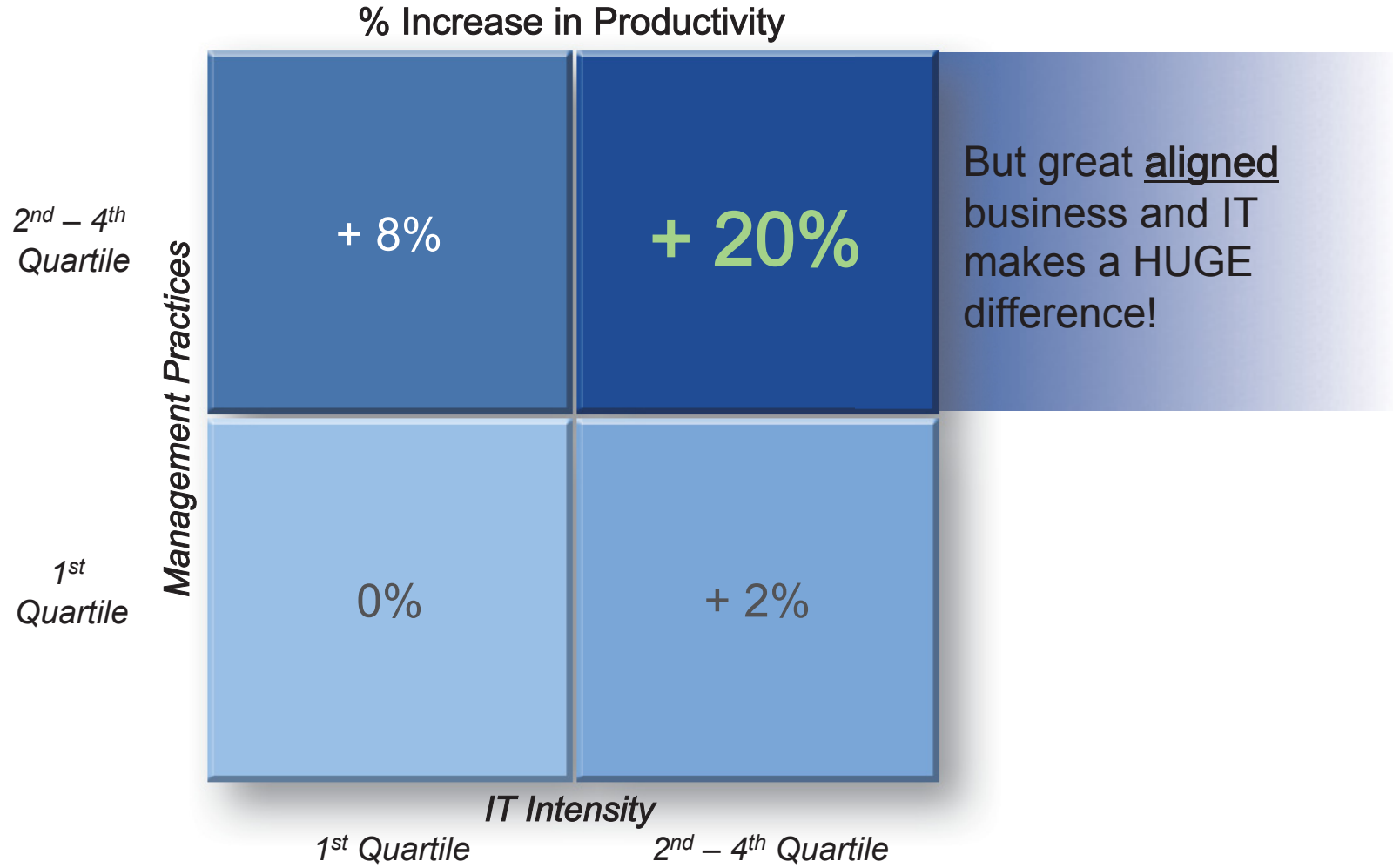
Technical Driving Issues

- Increased complexity of mission concepts
  - Planetary sample return
  - Multi-spacecraft coordination
  - Surface environments
  - Joint human-robotic missions
  - Multi-Nation / -Agency collaborations
- Desire for more flexibility
  - Enable science decisions as late as possible
- Onboard autonomy
  - More functionality onboard
  - Migrate ground functions up to flight systems
- Desire to exploit new software technologies

Current System View



Improved Process and IT Makes a Difference…



Source: London School of Economics – McKinsey survey and analysis of 100 companies in France, Germany, UK and US

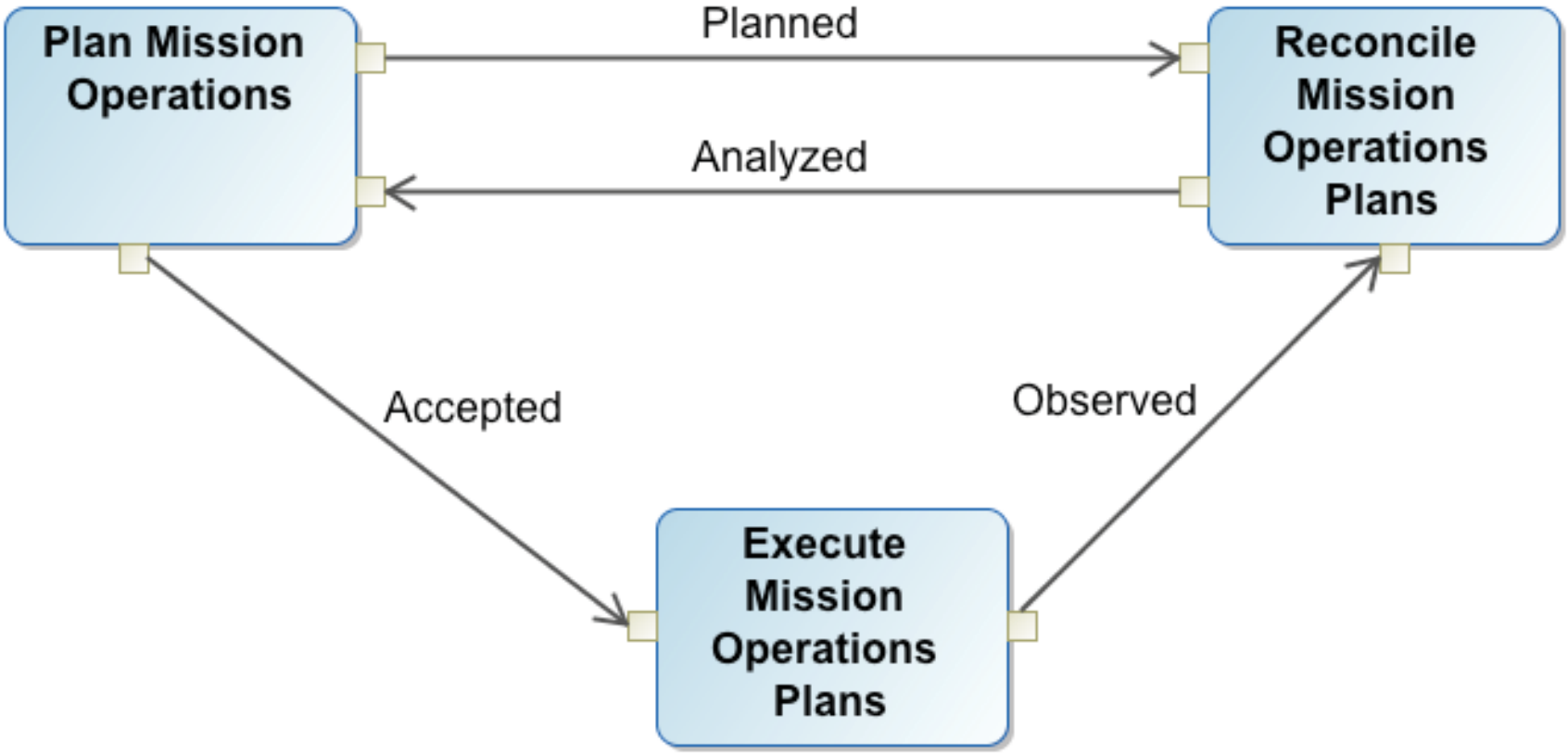
Slide courtesy of Peter Bahrs, IBM Office of the CTO

Future System

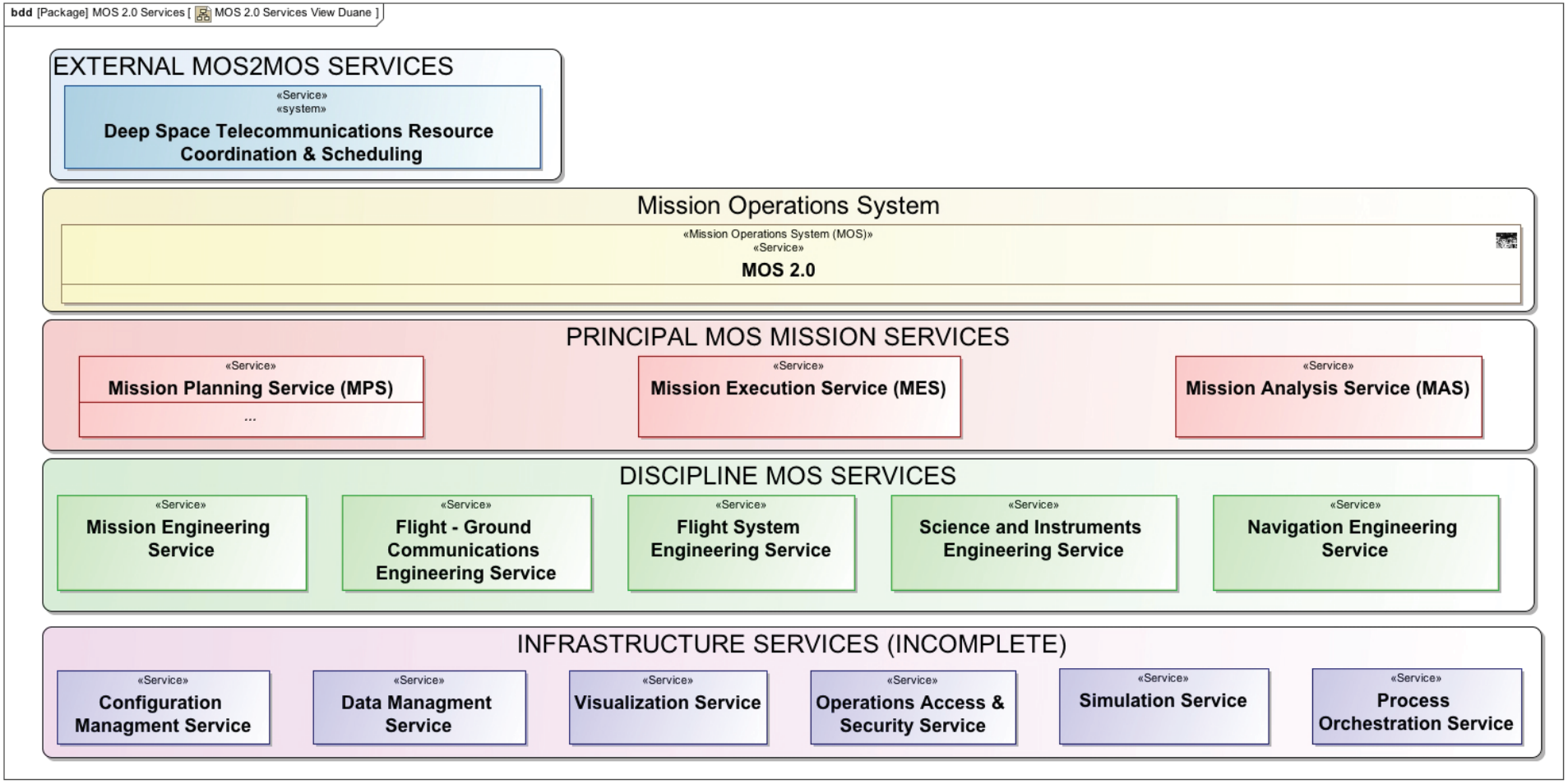
MOS 2.0

- MOS as a closed-loop control system
  - Enabled by a unified information model
  - Forces us to think “outside our stovepipes”
- Service orientation
  - Provide multimission capabilities to missions via services
  - Provide multi-mission value to MOS at each Phase in lifecycle
  - *Not just software services – must consider human-executed process and procedure*
- “Develop with what you fly with”
  - “Rapid prototyping” approach to design and implementation of MOS capabilities
  - Exercise system-level functionality early on
  - Consistent “cradle to grave” solutions
- Simpler ground software system based on sharing of common data structures

Control System View – "To-Be"

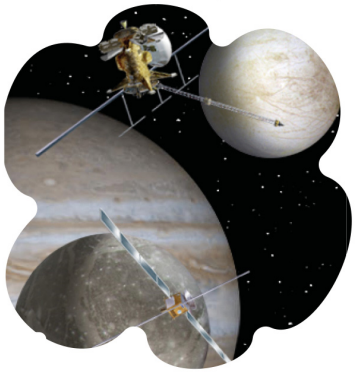


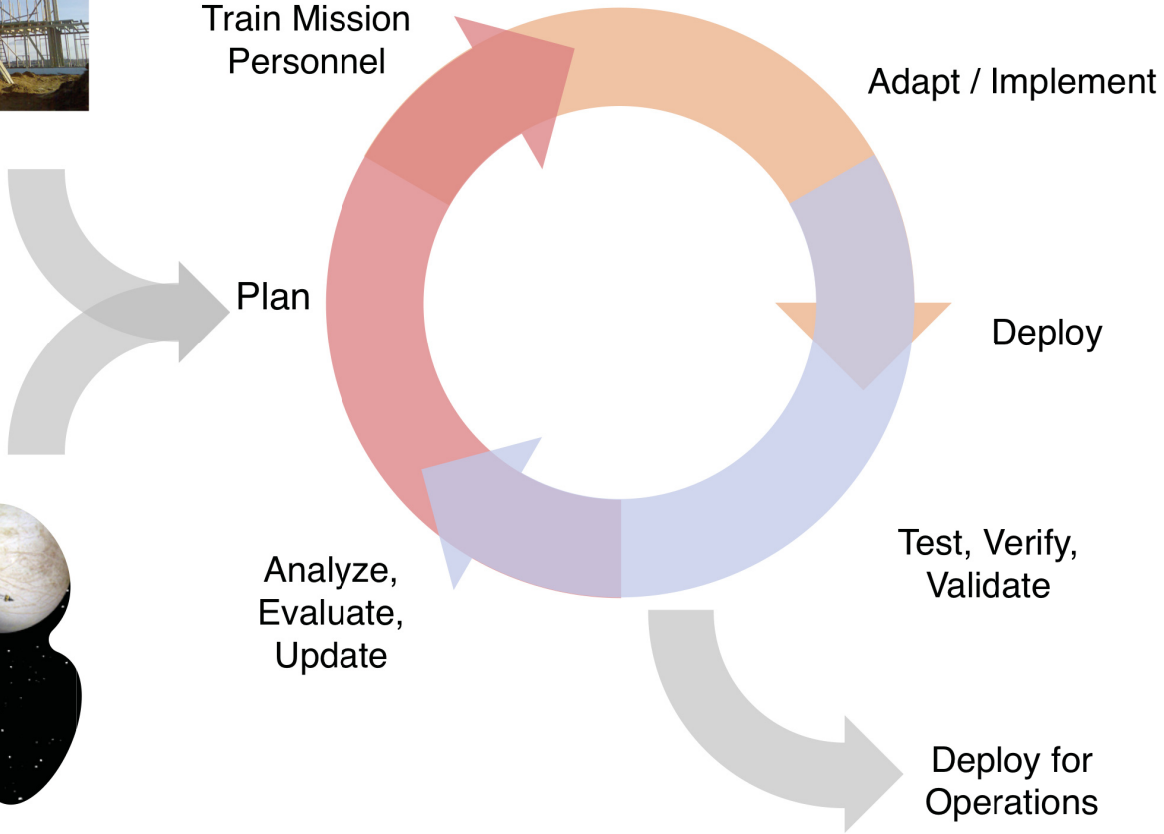
MOS 2.0 Services



To-Be: "Develop with what you fly with"

MOS 2.0 Framework





Information Architecture: Patterns

- Control system pattern
  - MOS commands and controls the flight system and the ground station
- Timeline pattern
  - Time-ordered information
- Service pattern
  - Unified way to organize capability, process, procedure etc
- Queue pattern
  - Quantify the performance of MOS
- Architecture pattern
  - Formal way to do systems engineering on MOS

JPL Planning System

- SEQ Revitalization Initiative
  - Use timelines as a common language for planning and sequencing
  - Uses a “Central source of truth” for information products
  - Enables “Closing the Loop”
  - Minimize software-imposed constraints on workflow
    - Use of files forces serial, unidirectional workflow
    - Fragmented, incomplete picture until final “big-bang” integration of all inputs
  - Provide a more operationally responsive planning system
    - Ability to make changes as late as possible
    - Ability to see impacts of changes to plan rapidly and early on in planning

Future Work

Realizations in AMMOS

- MOS 2.0 implementations
  - Demo / prototype for Mission Control
    - Sept. 2011
  - Unified Information Architecture
    - “v0.5” in 2011
  - Mission- & Discipline-level Services
    - 2012-2014
  - Next-gen (GDS 2.0) software capabilities
    - 2012 – …

Potential Collaborations

- Information Models
  - Timeline standards / API's
- System Architectures
  - Particularly related to the business processes of Mission Operations
- Extension / Application to Earth orbiters